Climate Change

Pictured Rocks National Lakeshore
National Park Service
U.S. Department of the Interior

What Does The Future Hold For Great Lakes National Parks?

Although numerous theories are being advanced to explain or predict changes in the earth's climate, scientists are reaching a growing consensus that the earth's climate is in fact getting warmer, and will continue to warm in the coming decades and centuries, as a direct result of human activities. No one is sure how this global warming will affect regional climate and weather patterns or how long it will take for the effects to be seen. Most agree that impacts will include a rearrangement of temperature and precipitation patterns across the globe, a rearrangement of the distributions of plants and animals, rising sea levels, and potentially critical stress on the major agricultural systems that currently feed the world's growing human populations.

Global warming may seriously affect our ability to protect the species and habitats that are now encompassed by national parks, forests, wilderness areas, and other nature reserves. A good number of implications for Great Lakes parks in the Midwest have been predicted as regional climate models have become more sophisticated. Changes in human habits may avert or reduce the projected impacts, but increased awareness of the problem is needed before people's activities will change.

Climate and Biotic Changes of the Past

The earth's climate has changed repeatedly throughout time as indicated by geologic and fossil records. During the Pleistocene (which lasted from approximately 2,000,000 years before present [ybp] until 9,500 ybp in upper Michigan) evidence shows that the global climate went through many cycles of cooling and warming, each averaging about 100,000 years in length -perhaps caused by cycles in the earth's orbital pattern called the Milankovich Cycle (Broecker 1989). Average temperatures fluctuated about 5°C (9°F) as the earth oscillated through a series of glacial (ice age) and interglacial periods. When the last glacial period (the Wisconsin) peaked about 22,000 ybp, the earth was about 3°C (5.4°F) cooler than it is today. The Wisconsin age glaciers (which carved much of the topography seen in Pictured Rocks National Lakeshore today) were gone by around 9,500 ybp. The interglacial period (which we are still in) peaked around 5,900 ybp when temperatures averaged about 2°C (3.6°F) warmer than today's.

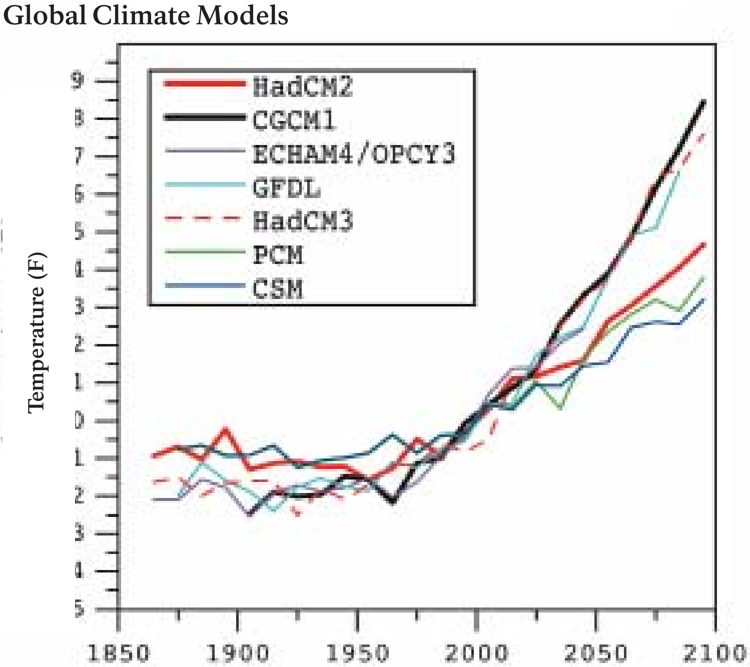
Where plants live is largely determined by climate and where animals live depends largely on where the plants are. Reflecting climate change, the distribution of plants and animals across the globe has also radically changed over time.

Fossil records show that climate changes during the Pleistocene caused species distributions to shift both in latitude and in elevation (Brubaker 1988). During several Pleistocene interglacial periods, when temperatures in North America were 2-3°C (3.6-5.4°F) higher than today, species were found several hundreds of kilometers north of their present distributions. Osage oranges and pawpaws grew near Toronto, manatees swam in New Jersey, and tapirs and peccaries foraged in North Carolina (Peters 1989).

Present and Future Climate Changes

Today's human activities are superimposing a different scale of climate change over the natural cycles that have governed the earth's climate for at least a million years (Abrahamson 1989). We may be causing climate to change more quickly than it ever has in the past and much more quickly than either plants and animals or human social, political, and economic systems can adapt to cope with the change. We are doing this by adding "greenhouse gases" to the earth's atmosphere, gases which trap heat

Projected U.S. Mean Temperature Anomalies Using Seven Global Climate Models

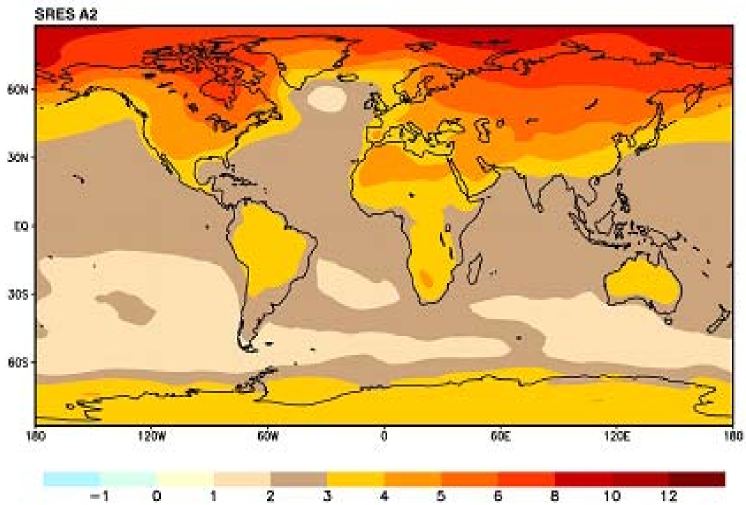


"National Assessment Synthesis Team, Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change (Washington, DC: U.S. Global Change Research Program, 2000)."

as glass does in a greenhouse, and make the earth warmer than it would otherwise be. Carbon dioxide (CO_2), the single most important greenhouse gas, is a byproduct of the combustion of fossil fuels and the clearing and burning of forests.

Another 20 or so greenhouse gases have been identified, the most important of which are: methane which is produced in flooded fields, rice paddies, the guts of cattle and other animals, landfills, and coal seams; chlorofluorocarbons used in refrigerators, air conditioners, and urethane foams; nitrous oxide released by coal combustion and in the breakdown of agricultural fertilizers; and tropospheric (lower atmosphere) ozone that is photochemically produced from the byproducts of fossil fuel emissions (not to be confused with the naturally occurring stratospheric ozone layer which blocks ultraviolet radiation from the sun) (Abrahamson 1989, Ramanathan 1989).

Earth has a natural greenhouse effect as a result of CO_2 and water vapor in the atmosphere. If the atmosphere did not contain these gases, the earth's surface temperature would be 33°C (59°F) lower and life as we know it would be impossible. But human activities beginning with the Industrial Revolution have already increased the level of atmospheric CO_2 alone by 30%. An increase of 0.7°C (1.3°F) in average global temperature since 1860 has already been measured - the 2004 meteorological year was the fourth warmest year in the period of accurate instrumental data. The annual-mean global surface temperature is 0.48°C above the climatological mean (1951-1980 average) in the GoddardInstitute for Space Studies analysis, which uses meteorological station



Annual mean temperatue change, 2071 - 2100 relative to 1990: Global Average in 2085 = 3.1C/38F. - SRESA2
Source: Intergovernmental Panel on Climate Change

measurements over land and satellite measurements of sea surface temperature over the ocean. Most scientists agree that this is a direct consequence of our addition of greenhouse gases to the atmosphere.

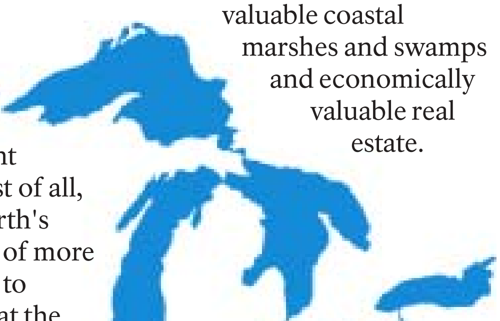
Even if we were to drastically reduce emissions of greenhouse gases right now, we are probably already committed to an equilibrium surface warming of at least 1-2.4°C (1.8-4.3°F). At present rates of emissions of greenhouse gases, by the year 2030 we would be committed to a mean global warming of at least 3°C (5.4°F) and maybe as much as 5°C (9°F). Over a century from now the earth could be 5-10°C (9-11°F) warmer.

Don't Worry - Be Happy?

Since the earth's climate fluctuates anyway, why should we care about current global warming? First of all, an increase in the earth's surface temperature of more than 3°C will take us to climatic extremes that the earth has not experienced in at least a million years (Ramanathan 1989). Second, this human-caused change is occurring about an order of magnitude faster than any climate changes evidenced by the geologic and fossil records. The changes at the end of the last ice age spanned several thousands of years. The changes currently being predicted may happen over the course of only a few centuries - perhaps decades - and may not be reversible.

Because our understanding of the highly complex global link between ocean currents, atmospheric patterns, and climate is limited, it is difficult to predict the precise ramifications of global warming for specific regions. However, there is some agreement on the following points. (Abrahamson 1989)

Global warming could cause accelerated melting of the polar ice caps which would raise sea levels anywhere from 20 cm to 2 m in the next century, thereby inundating currently occupied landscapes, ecologically valuable coastal marshes and swamps and economically valuable real estate.



Several National Parks on both coasts occupy areas that could be flooded.

Climate change will be amplified at higher latitudes; arctic regions may experience two to three times the warming experienced in the tropics. The earth as a whole will be more humid and wetter, but the geographical and seasonal distribution of precipitation will change. Summer soil moisture may be significantly reduced in many of the world's major agricultural regions including the U.S. grain belt, the Canadian prairie provinces, the Ukraine, and northern China. One study predicts that rainfall on the Great Plains may decrease 40% (Peters 1989); a 2°C (3.6°F) temperature increase may cause the water supply in the Missouri River drainage to drop by 64% (Revelle & Waggoner 1989).

Extreme weather events - heat waves, droughts, hurricanes, tornadoes, thunderstorms -will become more frequent.

A great deal of rearrangement of plants, species, and ecosystems will occur and many species may become extinct because of global warming, as is discussed below.

A Changing Great Lakes Region

Over the last century, the average temperature in Ann Arbor, Michigan, has increased from 46.6°F to 47.7°F, and precipitation in some locations in the state has increased by up to 20%.

Over the next century, Michigan's climate may change even more. Based on projections given by the Intergovernmental Panel on Climate Change (IPCC) and results from the United Kingdom Hadley Centre's climate model (HadCM2), a model that has accounted for both greenhouse gases and aerosols, it is projected that by 2100, temperatures in Michigan could increase by about 4°F in all seasons (with a range of 2-8°F). Precipitation is projected to increase by 5-15% in winter, spring, and fall, and by around 20% in summer.

The amount of precipitation on extreme wet days in summer most likely would increase. The frequency of extreme hot days in summer is expected to increase along with the general warming trend. It is not clear how severe storms would change.

With global warming, the water temperatures of the Great Lakes and smaller lakes in the region could increase because of the warmer summer air temperatures and longer ice-free season. Warmer temperatures could degrade water quality by decreasing dissolved oxygen in the water and increasing the growth of algae.

Warmer waters in the region's lakes and streams would reduce favorable habitat for trout, whitefish, and other cold water fish species. A recent EPA study found that a warming of 4.5°F over the next 70 years could cut the habitat of brook, rainbow, cutthroat, and brown trout by one fourth to one third nationwide. A 4.5°F warming is slightly below the midpoint of the 2-8°F range predicted by climate models for the year 2100; the actual temperature change that occurs could be smaller or greater. Chum, chinook, pink, and coho salmon would experience similar habitat losses.

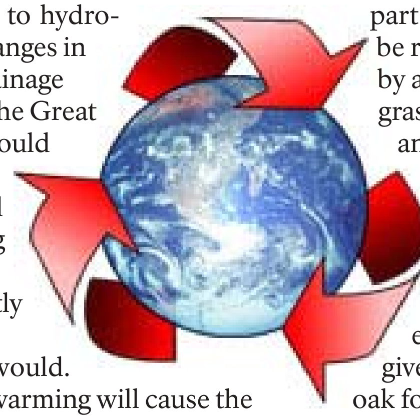
According to the study, Pennsylvania, New York, Ohio, Indiana, and Illinois would collectively lose 86 percent of their habitat for rainbow trout. These changes are expected to occur gradually over the decades ahead as the climate shifts. Would the Great Lakes basin be as popular a fishing destination if classic northern cold water species like pike, muskellunge, trout, and salmon became less common? Recreational fishing certainly would continue, but the experience might change.

Warmer waters also could affect the timing and frequency of "overturning," in which oxygen-rich surface waters sink and mix with other water layers in the lake. The lakes currently turn over in the spring and fall of every year. In a warmer climate, the overturning may not occur every year in all lakes. Turnover is the main way for deeper lake waters to become replenished with oxygen. Without enough dissolved oxygen, cold water lake fish and other species will be unable to survive in their deepwater habitats.

If the climate warms, ice cover on lakes and streams would not last as long as it does today. Streamflows could peak sooner in the spring because of earlier snowmelt and ice breakup. There already is evidence that the annual rising and falling of some of the Great Lakes occurs nearly a month earlier than it did 140 years ago. Changes in the timing and volume of peak streamflow also may affect fish and other creatures that live in the streams.

A warmer climate would lead to increased evapotranspiration -water lost to the atmosphere by evaporation and transpiration combined. Summer streamflows probably would decrease, reducing the water quality. Freshwater flow into the Great Lakes could decrease by 20 percent with a 4°F warming (slightly below the current mid-range estimate projected by climate models), potentially reducing lake levels by a foot or more.

Because lake levels respond to hydrologic changes in their drainage basins, the Great Lakes would respond to global warming very differently than the oceans would.



Global warming will cause the oceans to rise as warm water expands and freshwater from melting glaciers and ice sheets enters the sea. Water levels in the Great Lakes, on the other hand, are likely to fall.

Lower lake levels would reduce inputs to hydroelectric power facilities, increase the concentration of water pollutants, and require more dredging to maintain ship channels.

It is predicted that Great Lake levels may decrease from 2-5 or more feet as climate change worsens. Lake Superior levels are currently controlled by the sill of bedrock at Sault Ste. Marie. If lake level drops below this sill, the lake will slowly become a very different body of water than what we know today. Over long periods of time it could become a large salty inland sea as evaporation increases with increased temperatures and decreased inflow of water (Ecological Impacts from Climate Change: An Economic Analysis of Freshwater recreational Fishing, NOAA, 1995).

In Michigan, for example, changes in climate could cause the extent of forested areas to decline by as much as 50-70 percent. The uncertainties depend on many factors, including whether soil becomes drier and, if so, by how much. Hotter, drier weather could increase the frequency and intensity of naturally and human caused wildfires. The mixed aspen, birch, beech, maple, and pine forests found in the northern part of the state could be replaced over time by a combination of grasslands, savanna, and hardwood forests of oak, elm, and ash. The predominant hardwood forests in southern Michigan could give way to pine and oak forests.

There is concern among scientists that environmental changes may occur quicker than the plants can effectively respond to those changes. Even for species that are good dispersers natural or man-made barriers may block their dispersal. Mountains, the Great Lakes, deserts, unsuitable soils, agriculture, and urban areas may lie in the path between populations and suitable habitat. As Peters (1989) puts it, "Few animals or plants would be able to cross Los Angeles on the way to the promised land." Even if there are no barriers, there may not be any suitable habitat to move to. Species which depend on alpine or arctic habitats, for example, may literally have nowhere to go (Peters 1989). Lakeshore examples of this may include Arctic crowberry, Lake Huron tansy and Pitcher's thistle.

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

What Can We Do?

We all add greenhouse gases to the atmosphere whenever we use energy from fossil fuels. Residential energy use accounted for 19 percent of overall CO_2 emissions from the combustion of fossil fuels in 1997, and motor vehicle use accounted for approximately 20 percent. Here are a few actions that people can take to reduce their emissions.

- Walk, use mass transit, carpool with friends, or ride a bike whenever possible.
- When it is time to replace the family vehicle, consider one that gets more miles per gallon than your present vehicle.
- Convert home and office lighting to compact fluorescent bulbs. Turn off lights you are not using them.

- When it is time to replace an appliance or when buying or building a new house, look for the Energy Star® label identifying energy-efficient models.
- Buy products that feature reusable, recyclable, or reduced packaging to save the energy required to manufacture new containers and reduce greenhouse gas emissions from landfills.
- Educate others. Let friends and family know about these practical, energy-saving steps they can take to save money while protecting the environment. Share this paper with a friend.
- Encourage your company to join Waste Wi$e recycling programs, sustainable practices programs, and to buy office equipment with the Energy Star® label.

Money Isn't All You're Saving

- Encourage scientific research and public discussion on global warming and solutions such as energy efficiency and alternative energy.

Conclusion

Without a doubt, Pictured Rocks National Lakeshore and other national parks are increasingly valuable places for studying the impacts of global warming and other human activities, for protecting remnants of the earth's declining biota, and perhaps most importantly for motivating people to take actions like those described above on behalf of our planet and our livelihoods.

Predictions about the extent and the effects of human-caused global warming may sound improbable and apocalyptic, but many scientists feel that, far from exaggerating possible impacts, they may in fact be understating the magnitude of changes we are about to experience. Our release of CO_2 and other greenhouse gases into the atmosphere has been called a grand and gigantic experiment, but it is a highly dangerous one as well. We only have one earth to live with, and we may be risking serious ecological, economic, political, and social consequences if the experiment goes awry as it seems likely to do if we fail to make rapid changes in our pattems of energy and resource consumption.

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Web Resources

❧ www.epa.gov/globalwarming/
❧ www.giss.nasa.gov/
❧ www.esa.org/ecoservices/
❧ www.climatescience.gov/
❧ www.usgcrp.gov/
❧ www.whrc.org/
❧ www.ipcc.ch/
❧ www.met-office.gov.uk/research/hadleycentre/
❧ www.unfccc.int/
❧ www.ucsusa.org/global_environment/global_warming/
❧ www.gcrio.org/educ.html
❧ www.pewclimate.org/
❧ www.wri.org/
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❧ www.me3.org/issues/climate/
❧ www.nps.gov/glac/resources/bio7.htm#Global
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❧ www1.nature.nps.gov/
❧ www.nps.gov/piro/sustain

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